The focus on simulation of the "local" gene is to increase the adaptive value or fitness of introduced material. Results so far obtained revealed the positive effect of the local gene on the introduced material. This clearly shows that the cocoa breeders should not forget to conserve the old genes in their custody and to educate farmers to exercise caution in their effort to eliminate the old productive material. This approach will build up the "general purpose" genes to cater for the demands of a wider ecological range. The data are being subjected to stability tests and will be presented in part II of this series.

There are another four sets of crosses in addition to those listed above. The advantage of these crosses is not only the assimilation of desirable genes from earlier selections, but the broadness of the genetic base to cater for the demands of various ecological zones in Nigeria. It is a rewarding effort because the production base in Nigeria is being shifted and widened towards previously non-cocoa growing areas with different ecological demands.

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Cocoa Breeding at the Farmer's Plot in Nigeria (On Farm Breeding - 1)

The abundance of cacao collections in farmers' plots is a constant source of interest to cocoa breeders. There is often an array of cacao genetic material with desirable characters. The National Agricultural Research Programme (Project 3) of the Cocoa Research Institute of Nigeria, assisted by the World Bank, has as part of its mandate to make selections in farmers' plots. This has been decided so as to offset the threat of erosion of cacao genetic resources. A survey of selected farmers' plots in all of the ecological zones in Nigeria revealed the findings stated below.

1) The history of cocoa in Nigeria is known by some farmers. The on-going documentation of cacao germplasm in Nigeria can only be successful if farmers' records are included. The usefulness of this exercise is demonstrated by the example of a farmer, who designated his cacao germplasm as pre-independence, post-independence, pre-war and post-war.

2) Farmers have their own "finger-printing" techniques, which though crude, could be refined to make them scientifically sound.

3) Farmers have some knowledge about farming systems such as inter-cropping and these systems are widely used. Crops planted with cocoa include kola, oil palm, plantain, banana, citrus etc. The farmers know when to include these crops. Other maintenance practices are well known by farmers.

4) Farmers have some knowledge of the stability of their material. They can predict performance based on climatic trends.

The study revealed that where farmers alleged that their material is homogeneous, there is evidence of heterogeneity. It will be a worthwhile exercise to help the farmers to sort out this situation.

The next stage of this work is to select novel material from the farmers' plots and include it in our research programme for evaluation. Documentation of farmers' contributions to conservation, characterization and evaluation will be undertaken.

Against the foregoing findings, breeders are being advised to include farmers' plots in their breeding programmes. Further progress in this study will be reported in the near future.

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Characterization and Potential Utilization of Wild Cacao from French Guiana

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CIRAD-CP (formerly IRCC) has undertaken collections of wild cacao material, and of cacao cultivated in ancient times in French Guiana (Clement, 1986; Lachenaud and Sallée, 1993). Initially, it was believed that the latter category of cacao (Amelonado type) could have been derived from the indigenous wild cacao. However, isoenzyme analyses showed that the wild cacao is genetically very distinct (Lanaud *et al.*, 1993). This has recently been confirmed by RFLP and RAPD studies, which showed that this wild cacao is distinct from classical "Lower or Upper-Amazon" genotypes (Laurent, 1993; N'Goran, 1994). The RFLP analyses revealed another interesting feature of this material: the four accessions tested appeared to be homozygous for all the markers used.

The first collection of French Guiana wild cacao consists of about 150 accessions collected at 12 sites. This collection was planted at the COMBI Research Station of CIRAD, in 1988. This germplasm is being studied for vigour, incompatibility and 20 different characteristics of the fruit, bean and flower. One feature of these accessions is the relative variation in pod size and rugosity of the pod wall. The pods are generally bigger than those of Amelonado (up to 1.3 kg). The number of ovules per ovary varies between 37 and 50. The 34 genotypes tested so far appear to be self-incompatible. The high level of homozygosity could be explained by genetic drift, which may have occurred over the period of evolution of this material. For the plant breeder, this feature is of importance, as hybrids made with these accessions are expected to be more uniform.

In 1990, 22 accessions from the French Guiana expedition were transferred from the COMBI Research Station to Trinidad. The material was kept on the St. Augustine Campus of the University of the West Indies for post-quarantine observation. In 1994, it was introduced into the International Cocoa Genebank, Trinidad (ICG,T). Although this material is surrounded by clones infected with Witches' broom disease such as ICS 1 and SCA 12, the accessions have produced not a single broom since being established in the genebank! In the wild, this material is not affected by Witches' broom disease. The first artificial inoculations, carried out recently at CRU, seem to confirm the potential of this material for Witches' broom resistance. Studies are underway to confirm this resistance. Breeding with other clones resistant to Witches' broom is also underway.

In conclusion, the genetic uniqueness of French Guiana wild cacao, as well as the high level of homozygosity and possible resistance to Witches' broom, make these accessions of great interest. The evaluation of the breeding value of this material, as well as the mounting of new expeditions and collection missions in order to obtain wider representativity of this material are justified.

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Please note that the dates for the second INGENIC Workshop have been changed to November 25-26. This was unavoidable due to a public holiday on November 15.

Cocoa Breeding in Papua New Guinea

Yoel Efron

Cacao was introduced into Papua New Guinea (PNG) by the Germans from Samoa about 1900. Most of the material was Trinitario originating in Trinidad and Venezuela, and came via Java, Ceylon, and Cameroon to Samoa. It was a very mixed cacao with a very wide range of genetic diversity. There was a subsequent introduction of similar cacao to PNG from Java in 1932.

An additional introduction of significant value to the breeding programme was of the Upper Amazonian germplasm in the early 1960s.

Initially, prior to World War II, virtually all cacao was grown on plantations. From the early 1950s, it developed also as a small holder crop, and small holders now produce about two-thirds of the country's annual crop.

The major constraints for cocoa production in PNG are Vascular Streak Dieback (VSD) disease caused by *Oncobasidum theobromae*, and black pod and canker caused by *Phytophthora palmivora*. Termites, pantorhytes (*Pantorhytes* sp.), longicorns (*Glenea* sp. and *Oxymagis* sp.) and mirids are the most damaging insects.

Cocoa breeding was initiated after World War II by the Lowlands Agricultural Experiment Station (LAES) at Keravat, East New Britain. Later, in 1986, cocoa research was mandated to the Cocoa and Coconut Research Institute (CCRI). The first step was to collect open-pollinated seed from promising surviving trees and to plant them in progeny trials. This material provided the source of Trinitario genetic material for further selection and breeding work. Thirteen Trinitario clones were developed and officially released by LAES.

A severe outbreak of the previously unknown disease called Vascular Streak Dieback or VSD in many parts of PNG during the 1960s created havoc with cocoa research. This was investigated and found to be caused by *Oncobasidium theobromae*. Its effect was such that most of the trials were terminated. A full-scale breeding programme was resumed in 1972. The major efforts went into the development of Trinitario x Upper Amazonian hybrids. Naturally, emphasis was given to yield potential and resistance/tolerance to VSD using Trinitario and Amazonian clones that survived the VSD epidemics as parents. The first progeny trial was planted in 1973 and based on the results obtained, the first poly-cross hybrid SG1 was released in 1982. The hybrid was based on three Amazonian and three Trinitario clones crossed in all possible combinations.

Unfortunately, the SG1 Hybrids were not resistant to *Phytophthora palmivora*, which became more abundant in PNG. This was partially overcome by the release of the second hybrid group SG2, in 1988. This showed a higher level of resistance to black pod. The SG2 hybrids were based on 13 different crosses between six Amazonian and three Trinitario clones.

Though promising results were obtained at the experimental stage of the progeny trials, several problems (listed below) were identified with the SG2 hybrids in farmers' fields and plantations.

1) Yields were lower than expected.
2) Significant tree to tree variability in yield potential between and within crosses was found.